Chapter 2

An Introduction to Organic Compounds

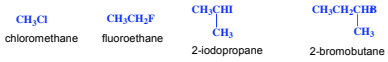
Functions, Nomenclature, Physical Properties, and Conformations

Adapted from Profs. Turro & Breslow, Columbia University and Prof. Irene Lee, Case Western Reserve University

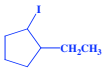
Common Functional Groups

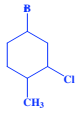
Class	General Formula
Halohydrocarbons	R–X
Alcohols	R–O–H
Ethers	R–O–R
Amines	R-NH_2

Nomenclature of Alkyl Halides



In the IUPAC system, alkyl halides are named as substituted alkanes





Structures of Alkyl Halides

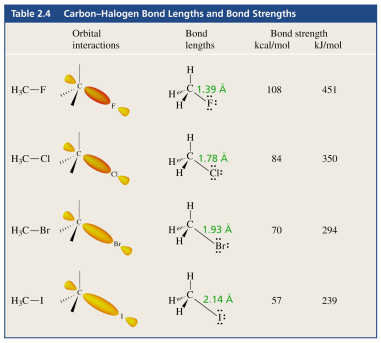
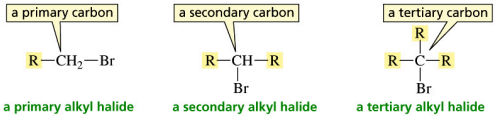


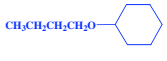
Table 2.4 Carbon–Halogen Bond Lengths and Bond Strengths

	Orbital interactions	Bond lengths	Bond strength kcal/mol	Bond strength kJ/mol
H_3C—F		1.39 Å	108	451
H_3C—Cl		1.78 Å	84	350
H_3C—Br		1.93 Å	70	294
H_3C—I		2.14 Å	57	239

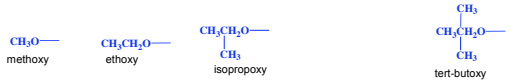
Different Kinds of Alkyl Halides



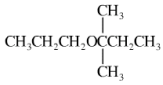
Nomenclature of Ethers



As substituents:



Click "Next" to view the progression of systematic naming of the compound.



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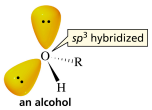
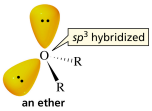
Structures of Alcohol and Ether

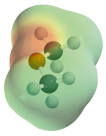


an alcohol

electrostatic potential map for methanol



an ether



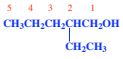
electrostatic potential map for dimethyl ether

Nomenclature of Alcohols

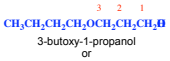
- In an alcohol, the OH is a functional group
- A functional group is the center of reactivity in a molecule

1. Determine the parent hydrocarbon containing the functional group

2-butanol
or
butan-2-ol



2-ethyl-1-pentanol
or
2-ethylpentan-1-ol

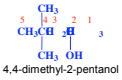


3-butoxy-1-propanol
or
3-butoxypropan-1-ol

2. The functional group suffix should get the lowest number

3-bromo-1-propanol

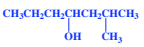
4-chloro-2-butanol



4,4-dimethyl-2-pentanol

3. When there is both a functional group suffix and a substituent, the functional group suffix gets the lowest number

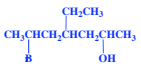
2-chloro-3-pentanol
not
4-chloro-3-pentanol



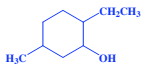
2-methyl-4-heptanol
not
6-methyl-4-heptanol

3-methylcyclohexanol
not
5-methylcyclohexanol

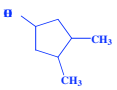
4. If there is more than one substituent, the substituents are cited in alphabetical order



6-bromo-4-ethyl-2-heptanol

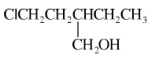


2-ethyl-5-methylcyclohexanol



3,4-dimethylcyclopentanol

Click "Next" to view the progression of systematic naming of the compound.



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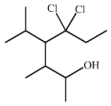
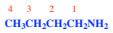
Systematically name the following compound, then click on each label to check your answer.

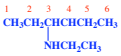
Functional group
Parent hydrocarbon
Substituents
IUPAC name



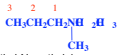
Nomenclature of Amines



1-butanamine
or
butan-1-amine

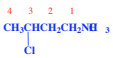


N-ethyl-3-hexamine
or
N-ethylhexan-3-amine

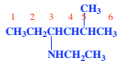


N-ethyl-N-methyl-1-propanamine
or
N-ethyl-N-methylpropan-1-amine

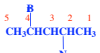
- The substituents are listed in alphabetical order and a number or an "*N*" is assigned to each one



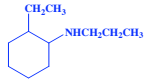
3-chloro-N-methyl-1-butanamine



N-ethyl-5-methyl-3-hexanamine

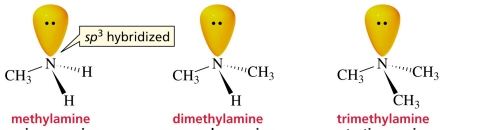


4-bromo-N,N-dimethyl-2-pentanamine



2-ethyl-N-propylcyclohexanamine

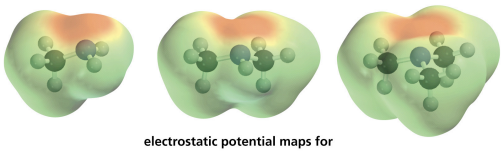
Structures of Amines



methylamine
a primary amine

dimethylamine
a secondary amine

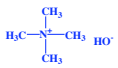
trimethylamine
a tertiary amine



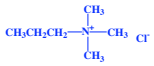
electrostatic potential maps for

methylamine dimethylamine trimethylamine

Naming Quaternary Ammonium Salts



tetramethylammonium hydroxide



ethyldimethylpropylammonium chloride

Other Common Functional Groups

Class	**General Formula**
Aldehydes	R-C(=O)-H
Ketones	R-C(=O)-R'
Carboxylic Acids	R-C(=O)-OH
Esters	R-C(=O)-OR'
Amides	R-C(=O)-N(R")R'

Attractive Forces

Ionic bonds

Covalent bonds

Hydrogen bonds

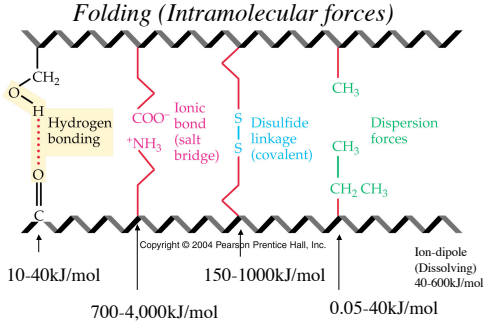
Dipole–dipole interaction

Ion-dipole

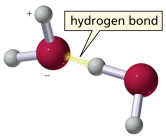
van der Waals force } Dispersion Forces

- The greater the attractive intermoleclar forces between molecules, the higher is the boiling point of the compound, eg. water.

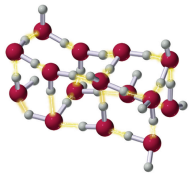
Protein Shape: Forces, Bonds, Self Assembly, Folding (Intramolecular forces)



- A hydrogen bond is a special kind of dipole–dipole interaction

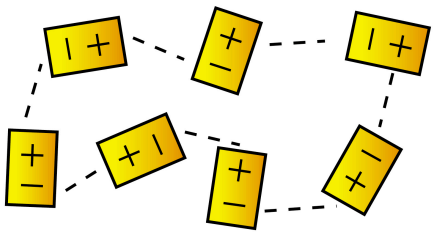


hydrogen bonding in water



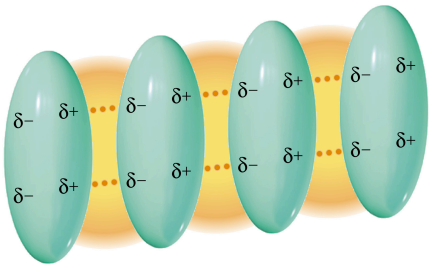
- What organic functions can have hydrogen bonding?

Dipole–Dipole Interaction



Dipole–dipole interactions are stronger than van der Waals force but weaker than ionic or covalent bonds

van der Waals Forces



Boiling and melting points of a compound increases with the increase in van der Waals force

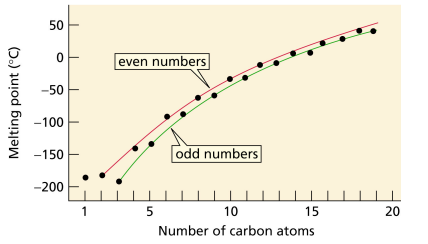
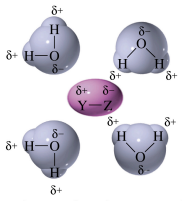


Table 2.6 Comparative Boiling Points of Alkanes and Alkyl Halides (°C)

	Y				
	H	F	Cl	Br	I
CH_3-Y	−161.7	−78.4	−24.2	3.6	42.4
CH_3CH_2-Y	−88.6	−37.7	12.3	38.4	72.3
$CH_3CH_2CH_2-Y$	−42.1	−2.5	46.6	71.0	102.5
$CH_3CH_2CH_2CH_2-Y$	−0.5	32.5	78.4	101.6	130.5
$CH_3CH_2CH_2CH_2CH_2-Y$	36.1	62.8	107.8	129.6	157.0

Ion-Dipole & Dipole-Dipole Interactions: *like dissolves like*

- Polar compounds dissolve in polar solvents & non-polar in non-polar



solvation of a polar compound (Y— Z) by water